

where d is the spacing of the crystal planes, and θ is the angle of incidence of the beam. The reflected x-rays are detected by an instrument located at a 2θ angle from the original beam direction. Since x-rays are reflected by the crystal's lattice planes rather than its physical surface, adjustment of the roll angle in the beam is required. A vertical translation stage is added to allow for the use of a different part of the crystal, or to retract the crystal completely out of the beam. Additionally, a horizontal translation stage is used to align the monochromator transverse to the beam.

The silicon crystal needs to be cooled by liquid nitrogen (LN_2). At 70° K , silicon's thermal conductivity is 17 watts/cm/ $^\circ\text{K}$, which is approximately 10 times higher than that at room temperature. Thermal gradients and deformations in the crystal are thus reduced by an order of magnitude at cryogenic temperatures. A direct vacuum-to-coolant interface is avoided as an accepted design practice at the APS.

3. Mechanical Design

The mechanical design of the crystal monochromator is governed by the requirement of providing a clear path for the x-ray flux passing through the crystal. All translational and rotational mechanisms are, consequently, designed outside the vacuum chamber. Figure 1 shows major components of the crystal monochromator: (1) Huber goniometer, (2) detector positioning mechanism, (3) vertical motion stage, (4) roll angle mechanism, (5) horizontal motion stage, and (6) crystal cooling configuration. These are described in more detail below.

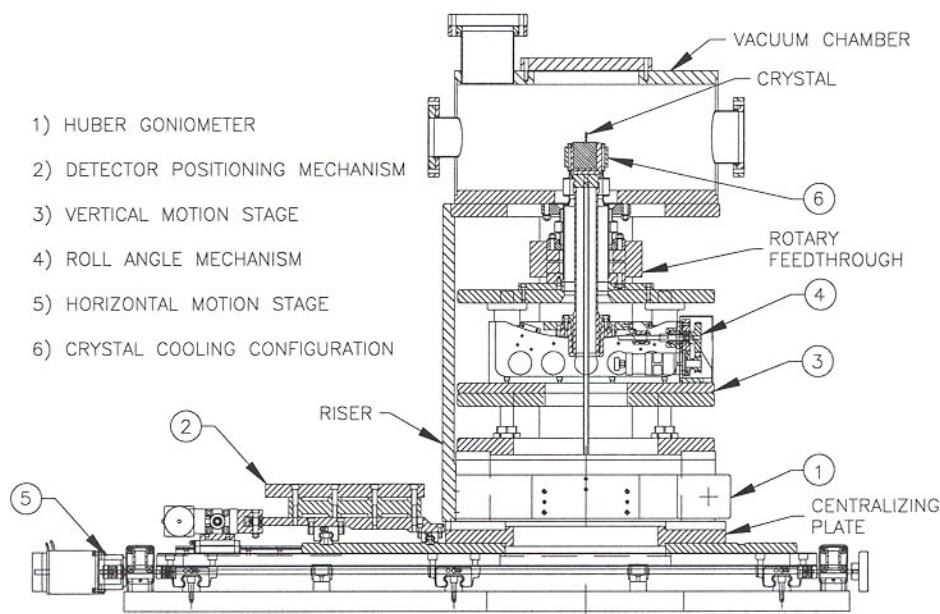


Fig. 1: Mechanical components of the diagnostics crystal monochromator.